Aug. 28, 1951 C. D. BROWN ET AL 2,565,647

CROSS-LAYING MACHINE

Filed June 24, 1946 8 Sheets-Sheet 1

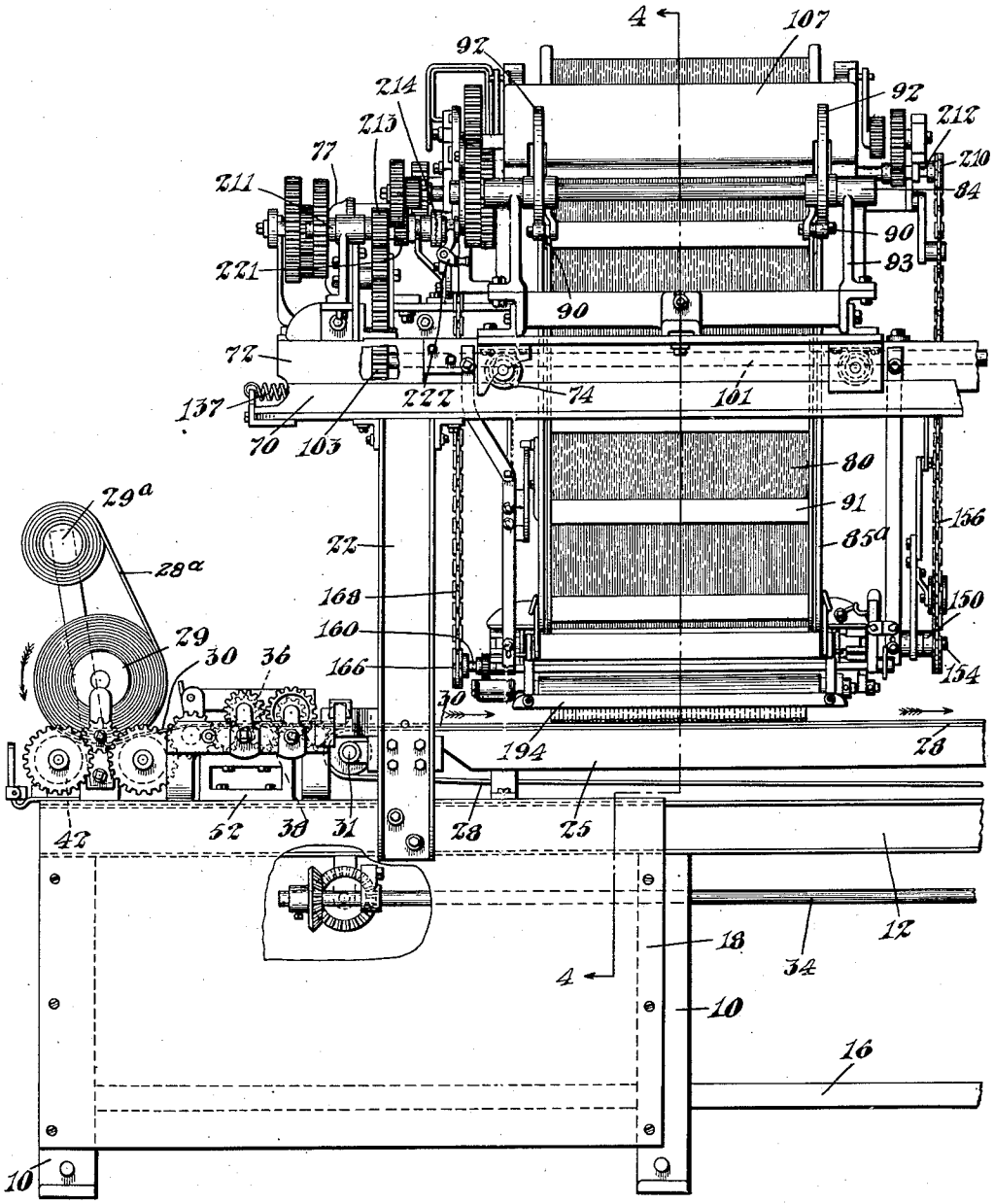


Fig.1.

INVENTORS.
CARL D. BROWN.
GEORGE E. REPASS.
BY
Thomas A. Hamilton

Aug. 28, 1951 C. D. BROWN ET AL 2,565,647

CROSS-LAYING MACHINE

Filed June 24, 1946 8 Sheets-Sheet 2

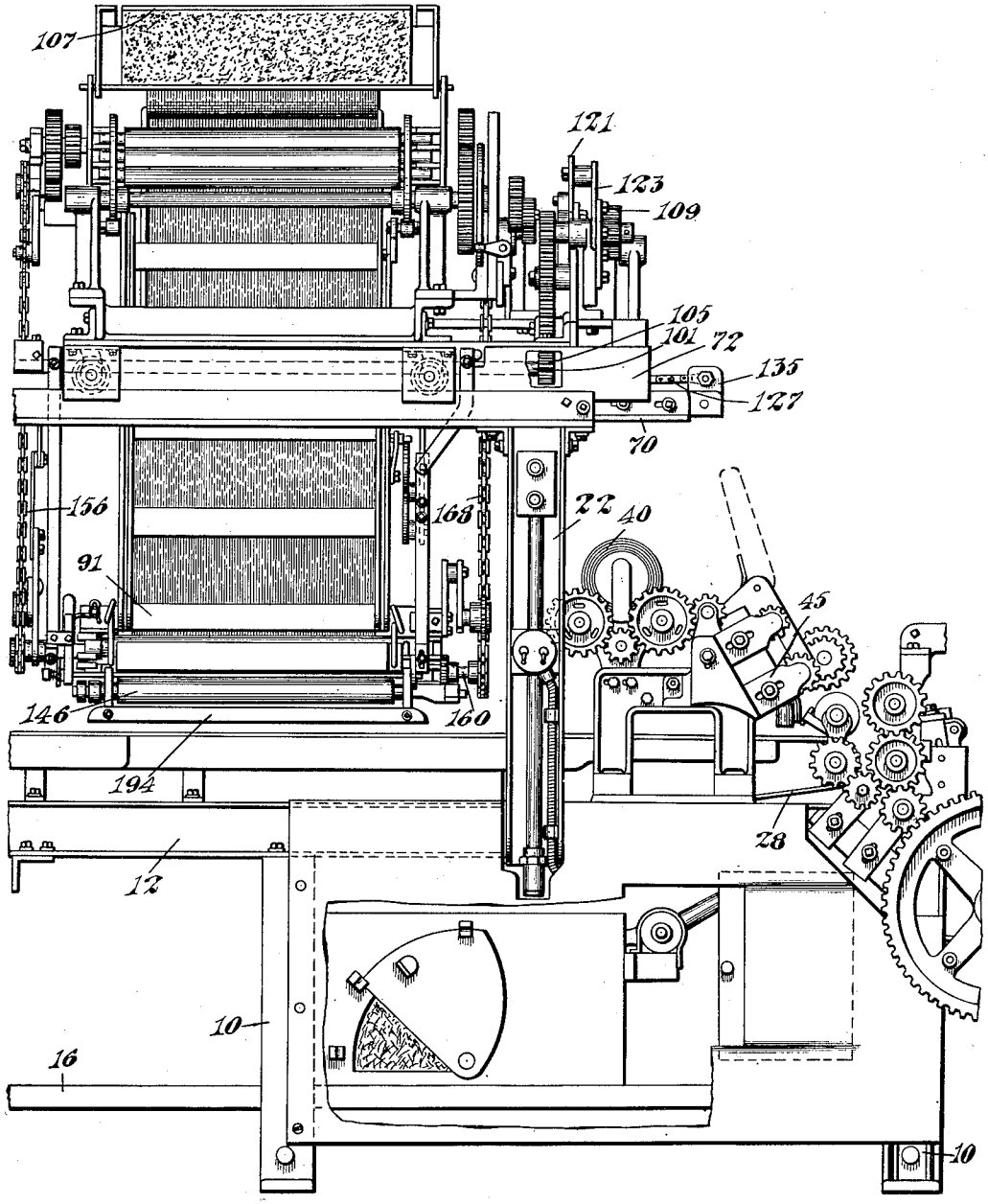


Fig.2.

INVENTORS
CARL D. BROWN
GEORGE E. REPASS
BY
Munson H. Hamilton

Aug. 28, 1951 C. D. BROWN ET AL 2,565,647

CROSS-LAYING MACHINE

Filed June 24, 1946 8 Sheets-Sheet 3

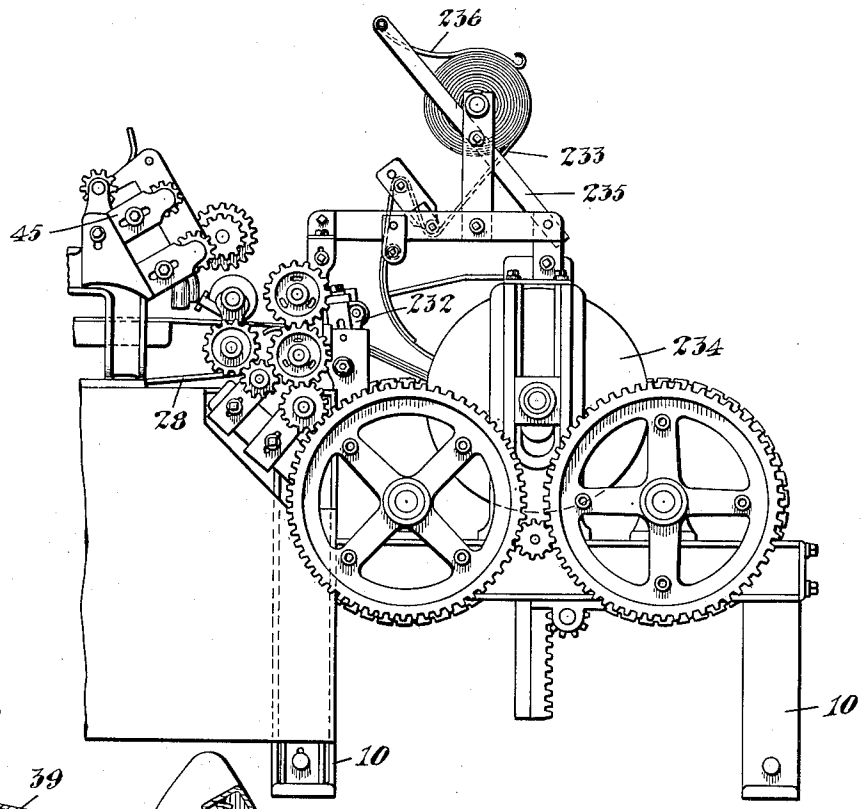


Fig. 3.

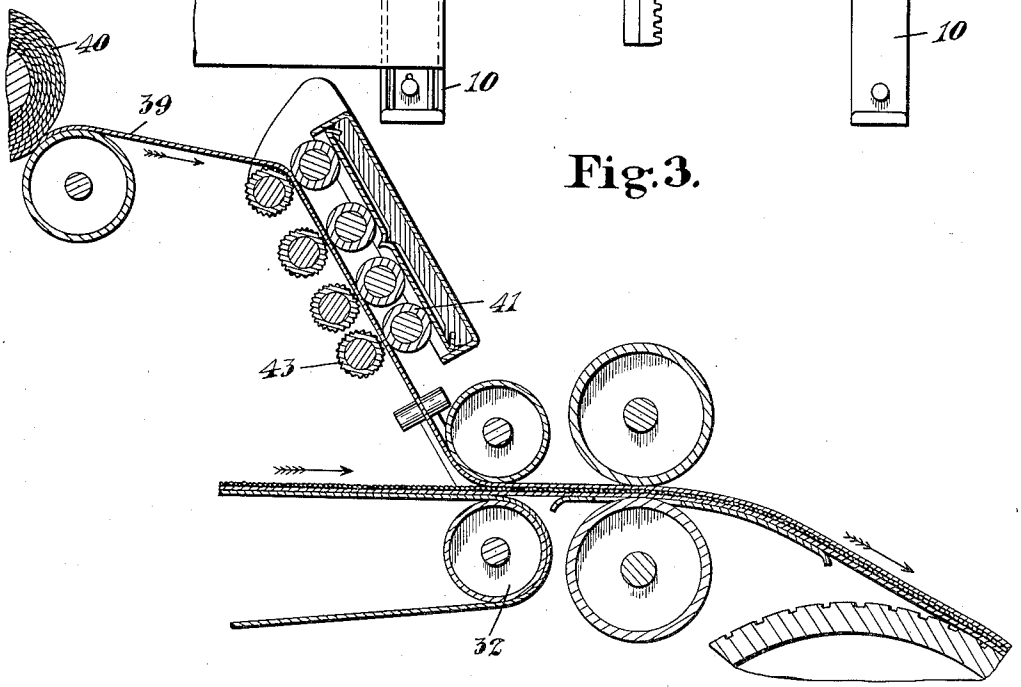


Fig. 5.

INVENTORS.
CARL D. BROWN.
BY GEORGE E. REPASS.
Munn & Hamilton

Aug. 28, 1951 C. D. BROWN ET AL 2,565,647

CROSS-LAYING MACHINE

Filed June 24, 1946 8 Sheets-Sheet 4

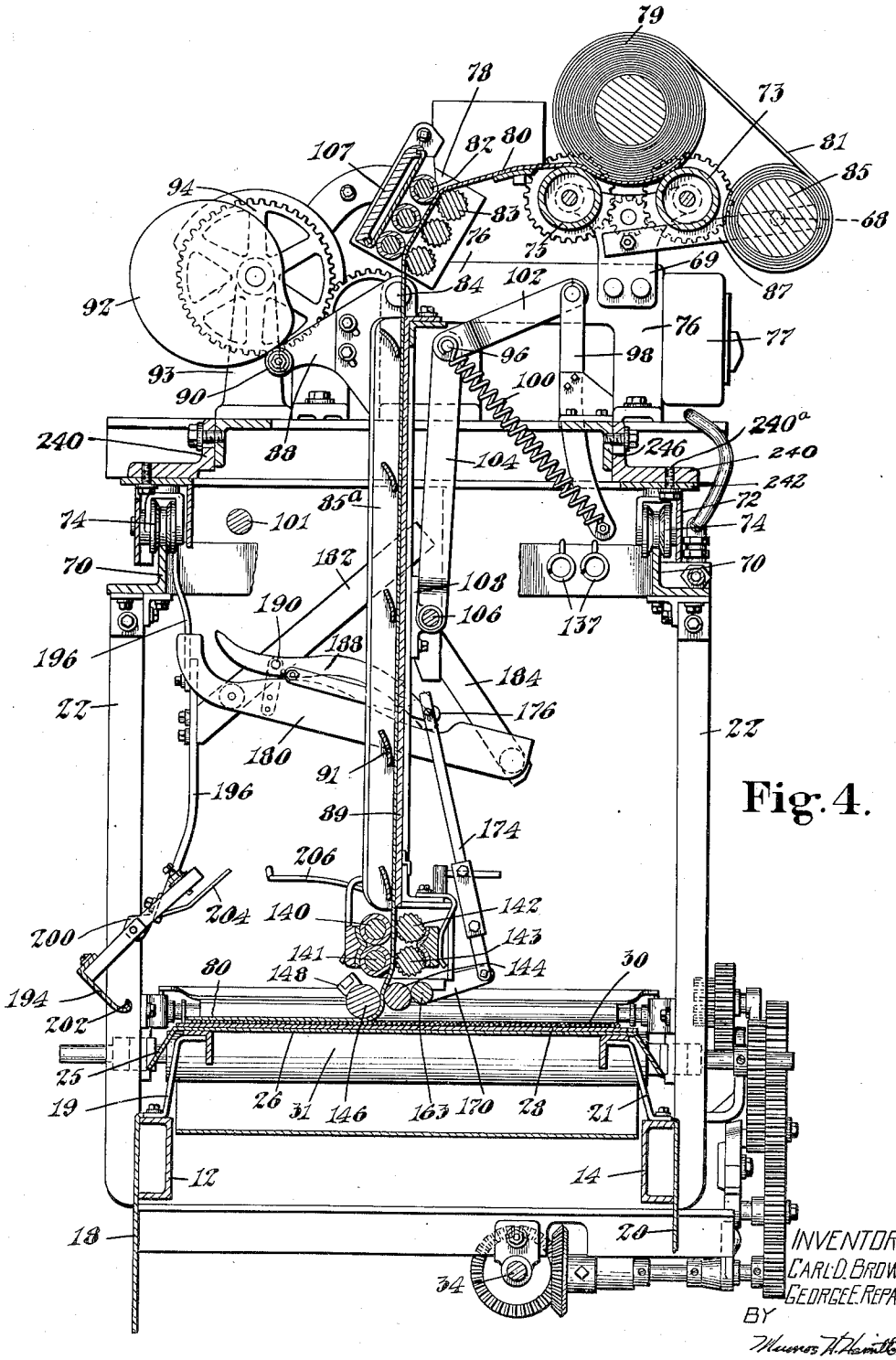


Fig. 4.

INVENTORS.
CARL D. BROWN.
GEORGE E. REPASS.
BY
Thomas H. Hamilton

Aug. 28, 1951 C. D. BROWN ET AL 2,565,647

CROSS-LAYING MACHINE

Filed June 24, 1946 8 Sheets-Sheet 5

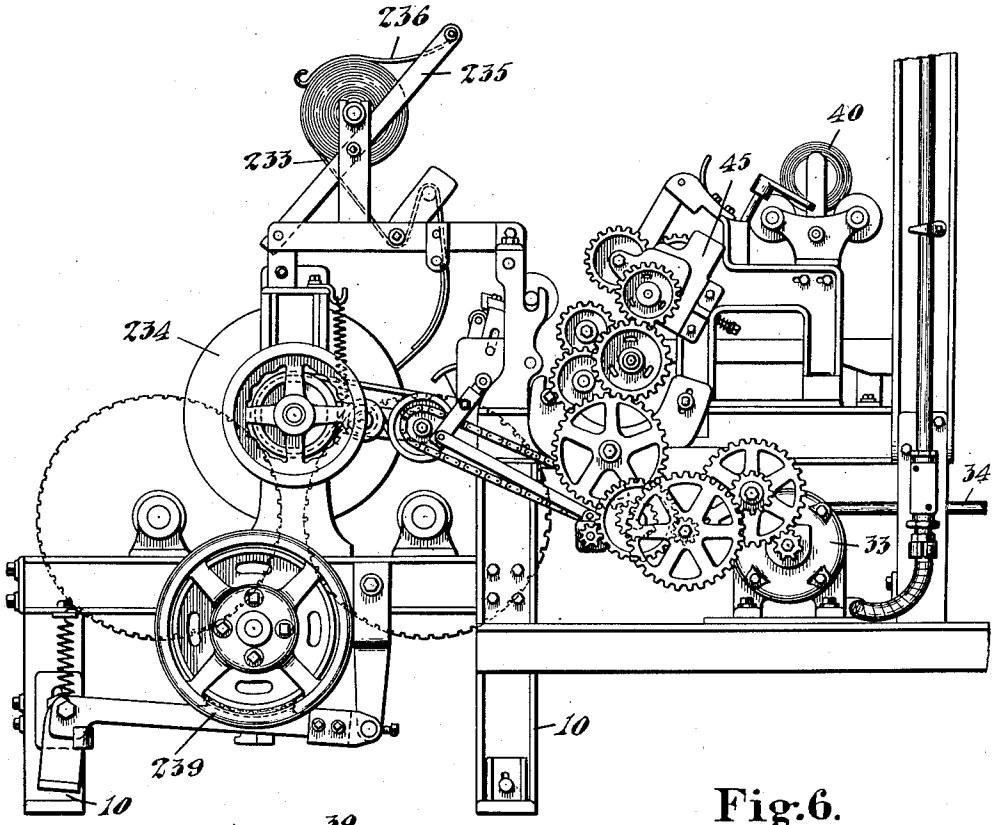


Fig.6.

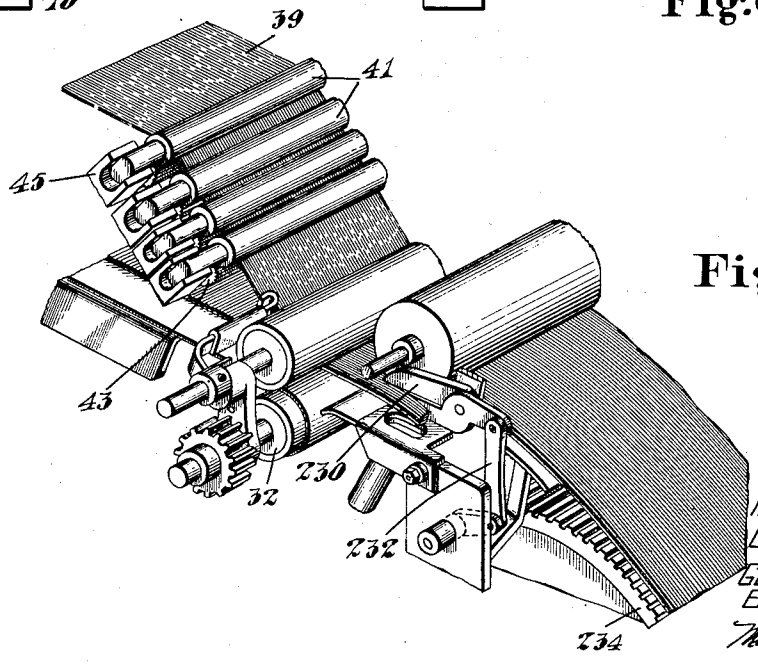


Fig.7.

INVENTORS.
CARL D. BROWN.
GEORGE E. REPASS.
BY
Thurman K. Hamilton

Aug. 28, 1951 C. D. BROWN ET AL 2,565,647

CROSS-LAYING MACHINE

Filed June 24, 1946 8 Sheets-Sheet 6

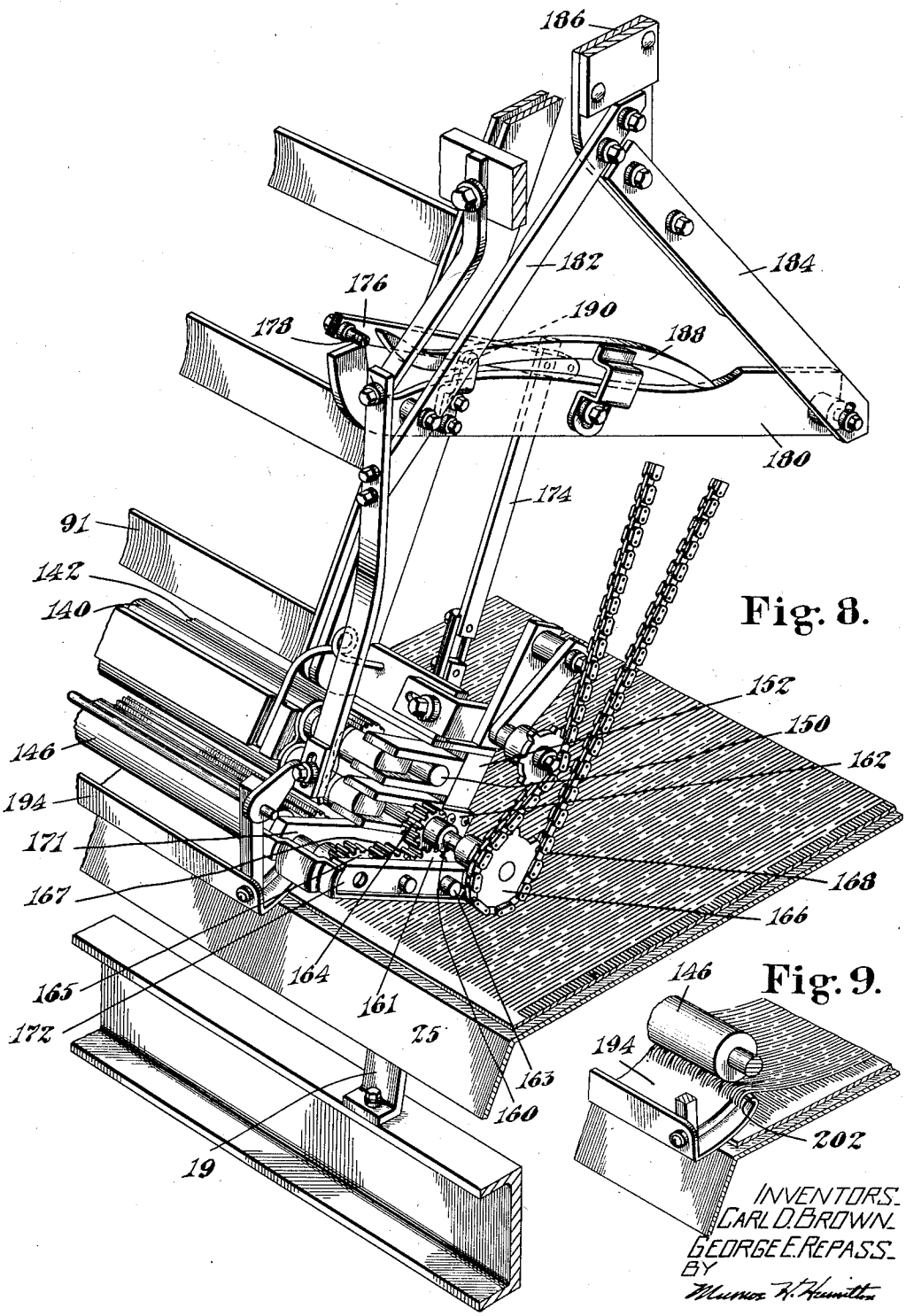


Fig. 8.

Fig. 9.

INVENTORS.
CARL D. BROWN.
GEORGE E. REPASS.
BY
Maurice R. Hamilton

Aug. 28, 1951 C. D. BROWN ET AL 2,565,647

CROSS-LAYING MACHINE

Filed June 24, 1946 8 Sheets-Sheet 7

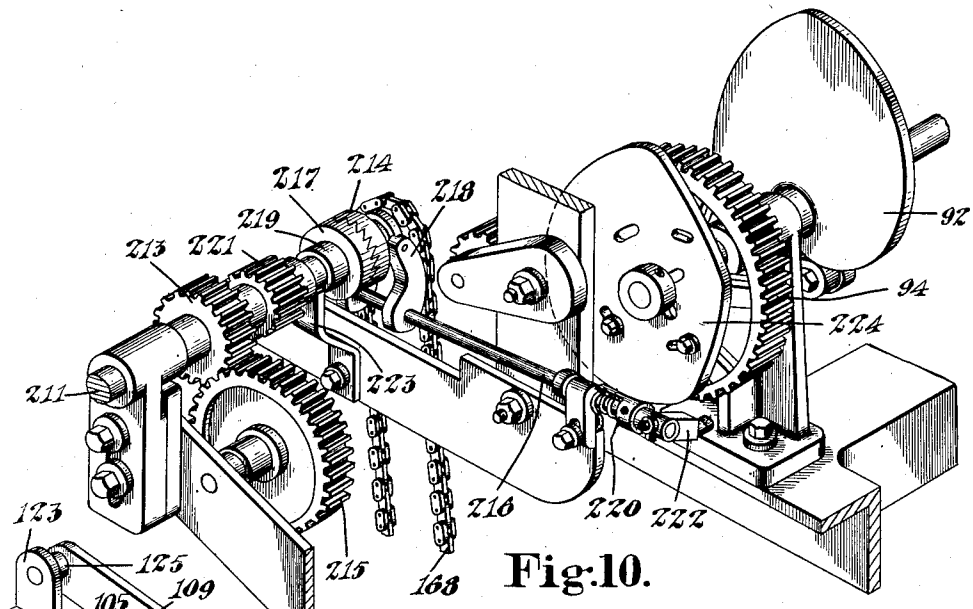


Fig.10.

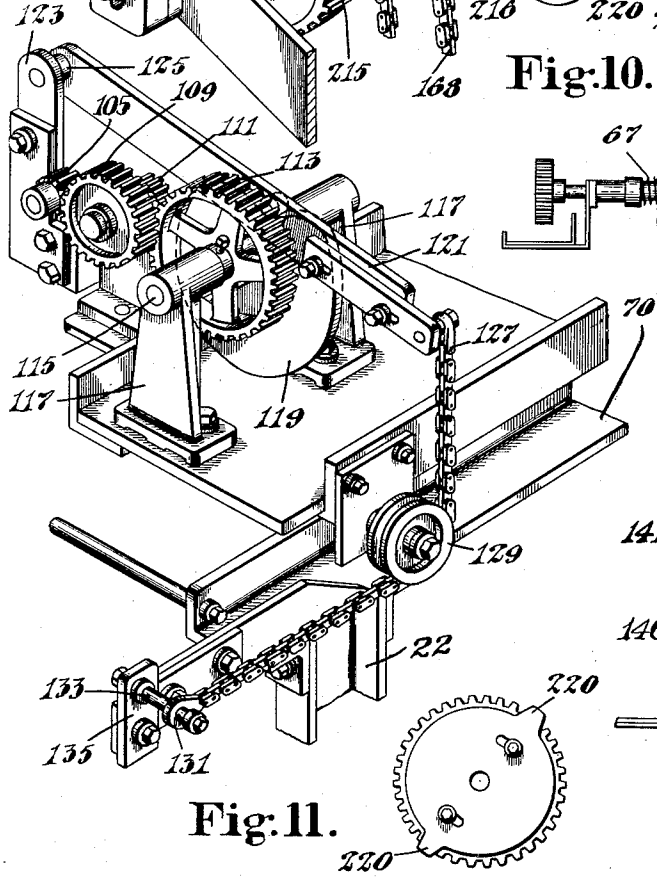


Fig.11.

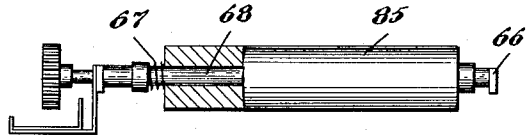


Fig.13.

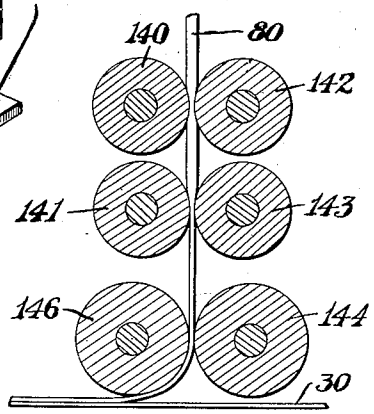


Fig.12.

Fig.14.

INVENTORS.
CARL D. BROWN
GEORGE E. REPASS.
BY
Warren H. Hamilton

Aug. 28, 1951 C. D. BROWN ET AL 2,565,647

CROSS-LAYING MACHINE

Filed June 24, 1946 8 Sheets-Sheet 8

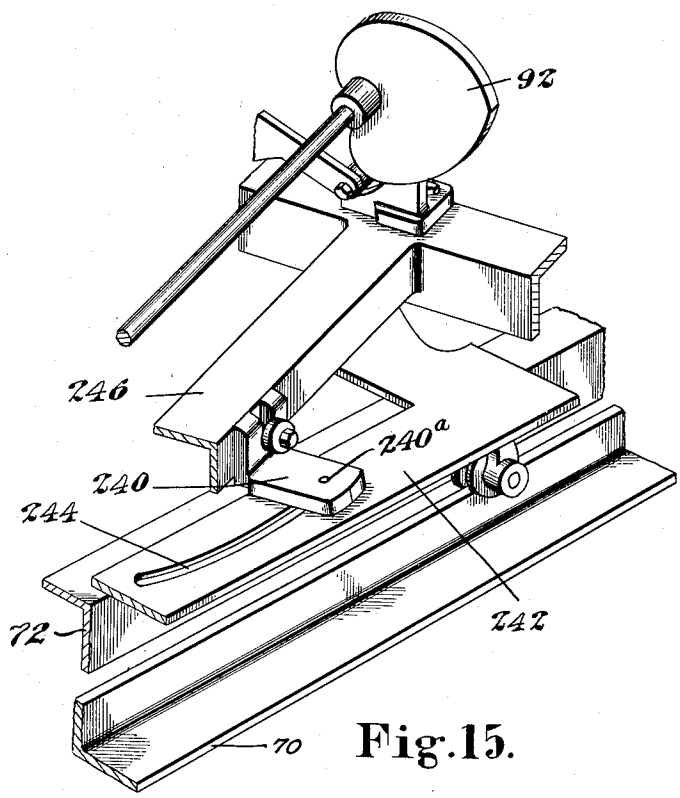


Fig.15.

INVENTORS
CARL D. BROWN
GEORGE E. REPASS
BY
Munson H. Hamilton

Patented Aug. 28, 1951

2,565,647

UNITED STATES PATENT OFFICE

2,565,647

CROSS-LAYING MACHINE

Carl D. Brown and George E. Repass, Hopedale, Mass., assignors to Draper Corporation, Hopedale, Mass., a corporation of Massachusetts

Application June 24, 1946, Serial No. 679,024

25 Claims. (Cl. 19—161)

1

This invention relates to a cross-laying machine for making fibrous sheet materials. More particularly, the invention is concerned with forming a web of material in which a plurality of layers of drawn fibers are arranged one upon another with the fibers in at least one of the layers extending angularly with respect to the fibers of the other layers.

An important consideration in a web of cross-laid fibrous material is the increased strength obtained both transversely and longitudinally of the web from cross-laying drawn fibers. This is in part due to the fibers being strainghtened out, in which position they are better able to resist a force tending to break them. Moreover, when straightened out and closely compacted against one another in somewhat parallel relation, they resist forces tending to separate them from one another. These points are of special interest when using the material as a retaining web to carry impregnating substances.

Development of fiber parallelism beyond a certain point is, however, limited due to the fact that the fibers are relatively short; also they have a pronounced tendency to curl up upon themselves after they have been straightened out. This makes it difficult to straighten the fibers as much as might be desired, and even after being straightened they tend to go back slowly to their curled position.

An object of the invention, therefore, is to deal with this problem and to provide a multi-layer sheeting which is characterized by a relatively high degree of strength coupled with increased uniformity in texture and appearance. It is also an object of the invention to provide improved mechanisms for cross-laying operations with particular reference to forming and handling thin webs or sheetings in which constituent fibers are straightened and permanently held in substantially parallel relation to one another.

We have found that these objectives may be achieved to an extent not heretofore possible by drafting thin layers of sheeting in which fiber parallelism is built up to a pronounced degree and carefully maintained during the operation of superimposing the layers upon one another. In this connection we have further devised improved mechanisms for progressively developing fiber parallelism in separate layers of sheeting and for bringing together the layers in a carefully controlled manner such that the fibers tend to become permanently held in parallel relation and thus resist curling.

An important feature of the invention, therefore, is a novel cross-laying operation by which

2

a multiplicity of cross-lengths of fiber are carefully laid upon a moving base web of fibers one upon another, with the fibers of the cross lengths being arranged in a highly uniform manner running substantially at right angles to the direction of travel of the base web, and with the individual fibers lying in parallel relation to one another and being uniformly spread out to avoid relatively thick and thin portions in the body of the web.

Another feature of the invention is an improved cross-laying mechanism combined with drafting rolls arranged to draw fibrous material into a thin sheeting, and to move in timed relation with a longitudinally travelling web. With this drafting and cross-laying mechanism is combined means for separating drawn fiber into short lengths, during the period in which it is being applied to a moving web.

Another feature of the invention consists in means for guiding the free ends of cross-laid lengths of fiber into a correct position along the marginal edge of a longitudinally moving web, and laying the cross lengths of fiber across a moving web with a light, positive pressure to prevent distortion and maintain proper alinement of individual fibers.

Another feature consists in forming an exceedingly desirable selvage in the finished stock by providing uniformly sheared free ends of the cross lengths of fiber interposed between edges of upper and lower longitudinally extending webs. The sheared stock is united with the edges of the longitudinally extending webs to provide fabric edges having a cross-sectional dimension which is substantially uniform and which corresponds to the thickness of the composite web measured at points intermediate of its edges, thus avoiding a rough unfinished appearance.

Another feature of the invention is a method of compacting and protecting the drawn fibers of a web or sheeting with a backing member to facilitate greater development of fiber parallelism. Various other novel features will be described in connection with the detailed description of the machine.

In the accompanying drawings:

Fig. 1 is a side elevational view of a part of the cross-laying machine of the invention;

Fig. 2 is a side elevational view of another part of the machine, being a continuation of the structure illustrated in Fig. 1;

Fig. 3 is a side elevational view of an end of the machine, being a further continuation of the structure indicated in Fig. 2;

Fig. 4 is a cross sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a detail cross-sectional view;

Fig. 6 is a side elevational view further illustrating winding mechanism of the invention;

Fig. 7 is a detail perspective view illustrating shearing mechanism;

Fig. 8 is a perspective view illustrating cross-laying mechanism;

Fig. 9 is a detail perspective view illustrating a guide element;

Fig. 10 is a detail perspective view of a cam and clutch mechanism;

Fig. 11 is another detail perspective view illustrating means for advancing the carriage of the machine;

Fig. 12 is a diagrammatic view illustrating drafting rolls;

Fig. 13 is a detail cross sectional view;

Fig. 14 is another detail view of a cam member; and

Fig. 15 is a view illustrating adjustment means for the movable carriage of the machine.

The structure illustrated in the drawings constitutes a prefered embodiment of the invention and is described with reference particularly to fabricating a fibrous material such as cotton slivers. In this connection good results have been obtained from a machine which includes two cross-laying units, as shown in the drawings, operating with a relatively narrow web or sheeting moving in a longitudinal direction. It should be understood, however, that the invention is not intended to be limited to fabricating cotton fiber but may be practiced in connection with various other types of fibrous material such as other vegetable fibers, synthetic fibers, and the like. Similarly, the number of the cross-laying units, as well as the arrangement of these members and the top and bottom layers of sheeting may be varied in other desirable ways.

Referring in greater detail to the drawings, attention is directed to Figs. 1, 2 and 3 in which is illustrated a base on which fabrication of the composite material of the invention is carried out. The base is constructed with standards or legs 10 which support channel iron sides 12 and 14 extending lengthwise of the machine. The sides 12 and 14 are secured together in some convenient manner as by cross pieces occurring in spaced-apart relation along the machine. Numeral 16 denotes a center plate which further stiffens the base.

Mounted on the channel iron sides 12 and 14 are metal casing members 18 and 20 (Fig. 4). Secured to the channel irons are uprights 22. The sides 12 and 14 also support brackets 19 and 21 upon which is mounted a sheet metal member 26 having angularly projecting skirt portions 25. Supported on the member 26 is a conveyor belt 28 which passes around rolls 31 and 32 located transversely of the machine.

Mounted on the channel iron sides at a point in advance of the conveyor belt 28 are means for furnishing a bottom layer of fibers or sheeting to the belt; located directly above the belt are means for cross-laying short transversely disposed layers of fibers or sheeting to the bottom layer as it moves along up the conveyor belt; and at a point adjacent to the delivery end of the belt are mounted means for covering the cross layers with a top layer of fibers in the form of a web or sheeting. The means for furnishing the top and bottom layers are similar and are therefore first described.

Considering the means for furnishing the bottom layer of sheeting, numeral 29 denotes a roll of cotton fiber which may consist, for example, of a sheeting of fibers obtained by passing cotton slivers through preliminary drafting rolls and winding on a backing. The roll 29 is supported on lap rolls 42. A web or bottom layer 30 of sheeting is furnished by these rolls and passes between upper drafting rolls 36 and lower drafting rolls 38. The drafting rolls are supported in slides in a roller stand 52. The bottom layer 30 in passing between rolls 36 and 38 is subjected to a second drafting operation and as a result its fibers are further straightened. The layer 30 then passes under a presser roll and out on to the conveyor belt 28.

A backing member may also be used in furnishing a top layer, 39, similar to bottom layer 30. The layer 39 is furnished from a roll 40 mounted at the opopsite end of the machine as shown in Figs. 2, 5 and 7. The top layer 39 passes through series of drawing rolls 41 and 43, and thereafter is deposited upon the cross layers which have been applied during the travel of this bottom layer, as will be hereinafter described in greater detail. The drawing rolls 41 and 43 are located in front of roll 40 in an angularly disposed frame 45 supported on the base of the machine, as shown in Figs. 2, 6 and 7.

The two sets of drafting rolls for the top and bottom layers referred to, together with the conveyor belt 28, are driven by means of an electrical motor 33 supported in the machine base at its delivery end (Fig. 6). Motive power is applied through a suitable gear train such as that indicated in Fig. 6 of the drawings. This gearing drives the conveyor belt roll 32 as well as the roll of sheeting 40, through its respective lap rolls, and also the drafting rolls. A shaft 34, provided at either end with bevel gears, extends along the base of the machine and connects the gear train as shown in Fig. 6 with a second set of gears indicated at the lower right-hand side of Fig. 4. The second set of gears drives the roll 31 through lap rolls 42, also the drafting rolls 36 and 33.

The web 30 is relatively wide and preferably wound upon a backing member 28*a* which is wound on a roll 29*a*. In preparing the roll 29 in accordance with the method of the invention, drawing rolls are employed of increased length and diameter as compared with conventional rolls, to prove a relatively wide web of material. Layer 39 is similar in this respect to layer 30.

In these relatively wide webs of stock the fibers tend to be more firmly held together from the sides with the result that a greater degree of drawing of the fibers in a longitudinal direction becomes possible. Although the fibers in a relatively wide web such as noted may be drawn to a greater extent than is usually the case, they may become less firmly attached to one another. The fibers then tend to stand up from the web or sheeting, thus losing their parallel alinement and also making it difficult to separate adjacent layers of the wound sheeting as it is unwound for a subsequent drafting or cross-laying operation.

We have found that parallelism of fibers may be more effectively developed and maintained by furnishing a relatively wide sheeting of drawn stock which is wound on a backing web of some suitable material such as paper. The backing acts as a separating medium for preventing adjacent wound layers from becoming entangled. Moreover the backing is caused to exert a firm

pressure both during winding and unwinding which compacts the fibers in the exact parallel relationship assumed as the fibers come from the drawing rolls. When these compacted or pressed parallel fibers are unwound and delivered to a subsequent set of drawing rolls, the increased cohesion with one another permits a further drafting operation to be carried out with relatively greater attenuation of the mass of fibers while maintaining their parallel alinement. Backing members may be employed with any one or all of the supply rolls. A detailed discussion of a backing member appears in connection with the description of the cross-laying unit.

Considering now the specific cross-laying mechanism of the invention, the uprights 22 have bolted to them rail members 70 (Fig. 4). A movable carriage 72 is mounted on rollers 74 which run on the rail members 70. Secured to the carriage 72 is a base plate 242 carrying heavy angle supports 240 located on opposite sides of the carriage. Fixed to these angle supports is a frame member 246, on which are secured upright U-shaped brackets 76. Extending upwardly from the brackets 76 are arms 69 carrying lap rolls 73 and 75, on which is mounted a roll 79 of cotton sheeting. The arrangement described is further illustrated in Fig. 15, from an inspection of which it will be observed that this entire superstructure described is carried by the angle supports 240, in turn received on the movable carriage. A web 80 is supplied by the roll 79, preferably consisting of a thin fibrous layer or sheeting which has already been subjected to a drawing operation, and wound on a backing member 81.

The paper backing coming from roll 79 is rewound upon a roll 85 supported on bars 87 fixed to arms 69. As noted above it is helpful to maintain a light, constant tension on the paper backing as it is being unwound from the roll 79. For this purpose, we have provided for the roller 85 being driven at a rate slightly faster than the rate of unwinding of roll 79. In order to maintain proper tension as the roll of paper backing increases in diameter at the rewind, the roller 85 is slidably mounted on its shaft 68 (Fig. 13). At one end of shaft 68 is a coil spring 67 which resiliently urges the roller against a flange 66 formed on the opposite end of the shaft. The friction of the roller 85 on its shaft 68, together with the friction at the flange 66, develops a variable resistance, acting as a frictional clutch which permits winding speed of the backing roll to vary automatically with a uniform tension being preserved at all times. Similar tension winding means may be included with rolls 29 and 40.

Motive power for rolls 79 and 85 is supplied from an electrical motor 77 which is mounted on a plate at the side of one of the brackets 76. The motor 77 drives a set of gears which are generally located at the extreme left-hand side of the carriage 72, as viewed in Fig. 1. The rolls 79 and 85, as well as drafting rolls 82 and 83 mounted in angularly disposed roller stand 78 are driven by these gears.

The gearing also drives a gear 103 fixed on a shaft 101 which extends along the inside of the carriage and has fixed at its opposite end another gear 105 (Figs. 1 and 2). The gear 105 drives a second set of gears mounted at the right-hand end of the carriage 72 as viewed in Fig. 2. This second set of gears is similar to the set of gears referred to at the opposite end of the carriage, and serves to drive a second cross-laying unit including a roll of sheeting, lap rolls, drafting rolls, and a swinging frame, as may be observed from an inspection of Fig. 2. In the case of the second unit, a cover member 107 carrying a clearer cloth has been shown in an open position. The clearer cloth serves to keep the drafting rolls free from loose fibers.

The second set of gearing on the carriage includes means for advancing the carriage along the rails 70. Attention is directed to Fig. 11 in which we have shown small gears 109 and 111 in turn driving the gear 113. Gear 113 is fixed on a shaft 115 supported in bearing members 117. The shaft carries a cam 119 engaging with a lever 121 which is pivotally mounted on a stud 125 in a backet 123. Attached to the end of the lever 121 is a chain 127 which extends downwardly and around a pulley 129 and has its extremity secured to a collar 131. The latter member is pivotally mounted on a stud 133 fixed on an extension 135 of one of the rails 70, as shown in Fig. 2.

Rotation of gear 113 turns the shaft 115 carrying the cam 119 which acts against the pivoted lever 121, forcing it upwardly. This draws the chain 127 around the pulley 129 and the carriage 72 is urged forwardly along the rails 70. Advancement of the carriage by the cam action is carried out against a spring tension exerted on the carriage which causes the latter member to be retracted immediately upon the cam having reached the greatest point of travel. This tension is provided by one or more coiled springs 137 secured between the extremity of one of the rails and some convenient point on the carriage.

A web 80 from roll 79 is passed through drafting rolls 82 and 83 and its fibers are further straightened, being at all times carefully held down and maintained in uniform alinement. From the drafting rolls, the web 80 passes into a mechanism for feeding separate lengths of sheeting. This member includes a swinging frame which is pivotally suspended on the carriage 72, which comprises channels or side members.

The swinging frame consists of a web supporting structure made up of spaced-apart sides 85*a* extending between which is a metal base member 89. The web 80, as it moves downwardly, is supported on this base member 89. Guide strips 91 lightly maintain the web in position against the base member. These guide strips are arranged very close to the web in a position such that the curved under surfaces of the guides serve to gradually force down upstanding fibers.

The sides 85*a* of the swinging frame are rigidly connected to pivoted arms 88, the assembly being pivotally mounted on studs 84 projecting into U-shaped brackets 76. The arms 88 are of triangular formation and carry cam followers 90 engaged by cams 92. The cams 92 are pivotally mounted on an upright member 93 fixed to the carriage 72. The gear 94 actuated by the motor 77 through the gearing already referred to rotates, carrying with it cams 92.

As the cams 92 are rotated, the arms 88 are swung back, causing the frame to swing in a direction from left to right as viewed in Fig. 4. The travel of the cam 92 is so chosen that the frame is moved into a position in which it extends well beyond the right-hand edge of the web 30 on the conveyor belt as viewed in Fig. 4.

During movement of the swinging frame, the cam 92 acts against a tension exerted by a balance spring arrangement connected at the under side of the swinging frame, as may be observed

in Fig. 4. A coiled spring 100 held under tension has one end fastened to an arm 98 solidly mounted on the carriage. The other end of the spring is fastened to a pin 96 about which are pivotally secured extremities of two links 102 and 104. Link 102 has its opposite extremity secured to the arm 98 while link 104 has its opposite end pivotally mounted on a stud 106 which is passed through a plate member 108 attached to the swinging frame.

The balance spring arrangement described provides a carefully regulated tension on the swinging frame which permits this member to be moved by the cam mechanism in properly timed relation. It should be observed that the spring 100 is extended the greatest amount when the frame is at the extreme right-hand side of the machine as viewed in Fig. 4. In this position the pivot point of the link members is relatively near a line passing through the centers of the pivot points for the swinging frame. There is developed here a minimum amount of power or thrust and the oppositely directed force applied by the cams may therefore more easily push the frame back into this position. Now as the frame starts back the springs cause the links to straighten and as this occurs the pivot point of the links moves away from a line passing through the centers of the frame pivots. As a consequence of this, more power or thrust is developed even though the spring is under progressively less tension. Momentum of the swinging frame cooperating with the thrust of links, provides increasing power which reaches a maximum just beyond the middle of the swing and which is maintained as the frame swings across toward a position at the left-hand side of the machine as viewed in Fig. 4. It is pointed out that even though the tension of the springs grows less as the frame moves from right to left (Fig. 4), there is a compensating factor derived from the change in position of the pivot point of the links relative to the pivots of the frame; therefore less tension is required to do the work.

Movement of the swinging frame by the gearing and cam travel noted, is carried out in carefully timed relation to the movement of the belt 28 and the bottom layer of sheeting 30. This is achieved by timing the movement of the swinging frame so that it just completes one full cycle of movement during the period that the carriage carrying the frame is moved forwardly and then retracted. The speed of the carriage as it moves ahead corresponds exactly with the speed of the belt and sheeting, with the result that the swinging frame, in moving transversely across the web from left to right (Fig. 4), maintains a constant position with relation to a point on the moving web or sheeting 30.

This timed relation between the frame and web 30 is important in cross-laying separate lengths of fibrous sheeting, and especially lengths of sheeting in which the fibers are carefully drawn out into the greatest degree of parallelism. Slight deviation or irregularity at this point produces a non-uniformity of pattern which materially impairs the quality of the fabricated stock. The actual cross-laying of separated lengths of sheeting making use of the mechanism and movements described will now be set forth.

The web 80 passes down through its respective swinging frame and is engaged by another set of drafting rolls including roll 140 and roll 142; also roll 141 and roll 143. From these rolls the web 80 passes between a roll 144 and a presser roll 146 (Figs. 4, 8 and 9). Numeral 148 indicates a clearer strip for removing loose fibers from the presser roll.

Rolls 140 and 142 are driven by a chain 156 which rotates a gear 154 on a shaft 150 in a frame 152, shown at the right-hand side of Figs. 1 and 8. The shaft 150 is in turn connected by suitable gears to the two shafts carrying the rolls 140 and 142.

The remaining rolls 141, 143, 144, and 146 are driven independently of rolls 142 and 140 by a second chain 158 which rotates a gear 166 on a shaft 160 supported in a block 162 shown at the left-hand side of Fig. 1.

The arrangement of the rolls 141, 143, 144 and 146 may be more readily understood from an inspection of Fig. 8. This figure illustrates the swinging frame of the second cross-laying unit appearing in Fig. 2. However, the structure shown, although reversed in position, is exactly the same as that indicated at the right-hand side of the frame illustrated in Fig. 1, and the same numbers for respective parts of each frame are used.

As will be noted in Fig. 8, the shaft 160 has fixed thereon a gear 164 which meshes with another gear 161 freely rotatable on a shaft 163. The gear 161 drives two other gears 165 and 167. The shaft 163 is mounted in the bottom of the block 162 and has fixed thereto side plates 171 and 172 which include between them the gears 161, 165 and 167. It is pointed out that the side plates and enclosed gears pivot with shaft 163 as a complete unit and that the gear 164 meshes with and drives gear 161 in all positions. Rocking of the side plates and devices carried thereby with shaft 163 is controlled by a link member 174 (Fig. 4) pivotally secured to another link 170 which is fixed to the shaft 163.

The rolls 146 and 144 normally tend to drop down into a position such as that illustrated in Fig. 4. This movement of the rolls 146 and 144 is controlled by means of a cam mechanism attached at the upper extremity of the member 174. The cam mechanism includes a pivoted link member 176 which has at its extremity a roller member 178 (Fig. 8). The roller 178 is adapaed to engage in a curved track formed along one edge of a bar 180 suspended at either end from cross pieces 182 and 184. The two cross pieces are connected together to form a triangularly shaped structure which is attached to the carriage by a supporting strap 186. The roller 178 is normally held on the curved track by a pivoted spacing strip 188 which is pivotally pinned at 190. Movement of the roller along the track between the member 180 and the spacing strip 188 varies the angle at which the rolls 146 and 144 are disposed with respect to the bottom layer 30. When the roller passes all the way across the track from left to right, it escapes from the spacing strip and moves back along the upper edge of this member, thus gradually increasing the angle at which the rolls are arranged with respect to the bottom layer of sheeting 30. Further movement of the roller along the spacing strip results in the roller going beyond the tip of the spacing strip and dropping down on the curved track of the member 180. As it moves along this path the roller decreases the angle until the frame reaches a position approximately half way back when the angle again starts to increase.

In this manner, the presser roll 146 exerts a light uniform pressure against the web 80 as it

falls on the sheeting 30, beginning at a point at the extreme left-hand edge of the sheeting, as viewed in Fig. 4. The web 80 is thus smoothly laid upon the bottom layer 30 with the fibers at all times being held in a relatively constant state of alinement, which is carried out all the way across the sheeting 30.

In starting the cycle of operation of the swinging frame, it is necessary to position properly the free ends of the web 80 along the marginal edge of the bottom layer 30. In Fig. 9 we have shown a guide device for carrying out this operation at a relatively rapid rate without disturbing the parallel relation of the fibers. The device consists of a guide element 194 pivotally supported in bearing members 200 supported from straps 196 fastened to cross pieces 182. The guide member is formed with a curved lip 202 which is adapted to extend under the loose ends of fibers and bring them into contact with the roll 146. As the fibers are drawn over the lip they assume a relatively flat straight position. The guide member is provided with a curved flat spring 204 (Fig. 4) which is engaged by a hook 206 on the swinging frame as the latter member moves toward the guide. This swings the guide under the fibers into the position shown in Fig. 9. The spring is held in spaced relation to the member 196 and may be bent inwardly. This allows the frame to hold the guide in an engaging position while it is completing one swing and beginning another.

An important feature of the cross-lying operaction of the invention is the separation of a desired length of sheeting from the main web of stock after it has been placed in position on the moving web. This is achieved by stopping the drafting rolls 140 and 142 while continuing rotation of the rolls 141 and 143. Rolls 140 and 142, as already described, are driven independently of the rolls 141 and 143 by means of the chain 156 which is in turn driven by a gear on shaft 212.

The shaft 212 extends across in back of the swinging frame as viewed in Fig. 1. Attention is directed to Fig. 10 in which is illustrated a shaft 211 driving a gear 213 which in turn drives a gear 215 and shaft 101 (Fig. 2). The shaft 211 has fixed at its innner end a gear which drives the chain 168. Slidably mounted on the shaft 211, adjacent to the chain 168, is a clutch element 214 which is keyed to the shaft so that it is not rotatable on the shaft. The clutch includes the element 214 formed with teeth and a second clutch element 217 also provided with teeth which are complementary to those on the element 214. This second clutch element is fixed on a sleeve 219 which is freely mounted on shaft 211 and carries a gear 221 fixed to the sleeve. This gear 221 is connected to shaft 212 through gearing shown at the left-hand end of the carriage in Fig. 1.

The clutch element 217 is supported by a bracket 223 and the clutch element 214 is normally urged into engagement with it by a dog 218 fixed on a rod 216 which is resiliently held by a spring 220. This allows shaft 211 to drive gear 221 and through it shaft 212.

In order to interrupt rotation of shaft 212, therefore, means are provided for disengaging the clutch referred to. This operation is carried out by cam 224 mounted on the same shaft with cams 92 already described. During travel of cam 224 it engages against arm 222 secured to the outer extremity of rod 216, thus rotating this member and causing the dog 218 to slide the clutch element 214 rearwardly on shaft 211. It will be observed that during this operation, chain 168 is continuously driven, thus providing for the rolls 141 and 143 being independently driven as rolls 140 and 142 are stopped. Since each set of rolls exerts a positive grip on the web 80, the fibers will be pulled apart and a separate length of fibrous web terminated at this point.

The action of the cam is set to rotate the rod 216 and release the clutch at a point when the swinging frame has completed its travel across the bottom layer 30. Separation of the fibers occurs when rolls 142 and 140 stop, gripping the web 80 while rolls 141 and 143 advance the portion of web which has already passed through rolls 140 and 142. The cam 224 holds the clutch out of engagement while the swinging frame is moving back across the moving web releasing the clutch at a suitable point to cause the rolls 140 and 142 to again start feeding and to advance a free end of the web 80 into the guide element 194.

It is pointed out that the sheeting is firmly held at all points during the time the separate lengths are being united. In this connection especially, it should be observed that in each step of applying one layer of sheeting against another, the fibers are positively placed and held in a substantially right angular position rather than being allowed to drop or fall into the desired area. In this way disturbance of the fibers by air currents is prevented.

The cross lengths are preferably arranged so that their adjacent edges are located in overlapping relation, an overlap of less than one inch is usually desired. However, the overlap may be increased to build up the thickness of the finished stock. The two cross-laying units apply two spaced-apart webs simultaneously. These may be increased in number. The top layer 39 is applied over the previously deposited cross lengths in the manner already described. As soon as the top layer is in place, shearing of the free ends is carried out by shears 230 (Fig. 7), operated by a link mechanism 232. Cut ends are collected in a box shown in Fig. 2. The sheared material is then wound upon a backing 233 about a roll 234, provided with friction wheels 239, as shown in Fig. 6. The backing is supported in a frame 235 which may include a spring 236 for causing the backing to unwind under tension and to be so advanced to the calender roll.

We may desire to modify the apparatus and method described in various ways. For example in a material such as bias tape, it may be desirable to vary the angle of disposition of the cross lengths to secure a diagonal weave or pattern. This may be done by varying the direction of movement of the swinging frame so that it moves in a direction diagonally across the bottom layer.

Fig. 15 illustrates means for varying the direction of movement of the swinging frame and includes a swivel arrangement for varying the position of the angle supports 240, a plurality of which are employed to support base member 246, from certain parts attached to which the swinging frame is suspended as described above, and further illustrated in Fig. 4. The swivel arrangement includes a curved slot 244 formed in the plate 242. Vertical clamping bolts 240*a* are passed through the angle supports 240 and the slots 244 as noted in Fig. 4, and the swinging frame may thus be turned in a horizontal plane into an angularly disposed position relative to

the carriage 72 and the underlying layer of fibers.

Another modification of the invention consists in means for operating the swinging arm by disconnecting the cam arm 222 so that clutch 214 is permanently held in engagement. In this case the cross lengths, instead of being broken, become folded over upon one another in a diagonal manner to produce novel designs and patterns. When this type of cross-laying is carried out it may also be desired to avoid relatively thick folded edges along the points where the cross lengths are doubled over upon one another. In Fig. 14 we have illustrated a modified type of cam member which may be substituted for the cams 224. This alternate form of cam is constructed with a projection 220 which causes the clutch 214 to be disengaged for a very short period. By means of this the rolls 140 and 142 are caused to stop rotating for only a short interval, with the result that the web 80 becomes thinned but not completely separated. When these thin portions are folded or doubled over upon one another, there is obtained a relatively thin line of folding which adds materially to the appearance of the reversely folded stock.

From the foregoing it will be apparent that we have provided an improved mechanism for forming a cross-laid material from a plurality of layers. Each layer is subjected to two drafting operations. After the first drawing operations, the respective layers are wound upon a backing which both separates adjacent layers and compacts the drawn fibers to hold their parallel relation. As the respective layers are unwound, the backings are held under tension to further compact the fibers just before they are passed through the second set of drawing rolls. As the bottom layer comes from its respective set of drawing rolls, it is immediately covered by the cross layers and then rolled with a positive pressure to unite the fibers of the cross layers with the fibers of the bottom layer. Immediately succeeding the step of rolling the cross lengths, the top layer is applied and rolled with pressure. The composite web is then wound preferably on a backer.

In this way the fibers are drawn out in a high degree of parallelism but yet are maintained in compacted relation to provide increased strength and much greater uniformity of pattern, adding to the appearance of the material.

While we have shown and described a preferred embodiment of our invention, it should be understood that various changes and modifications may be resorted to, within the scope of the invention as defined by the appended claims.

We claim:

1. A machine for fabricating multilayer sheet material from drawn fiber sheeting, said machine including a base, a conveyor belt mounted on the base, a roll of drawn fiber sheeting mounted at one end of the said conveyor belt and adapted to deliver a length of sheeting longitudinally along the conveyor belt, said roll of sheeting including a backing, means for winding said backing with a light tension to develop a pressure on the said roll as it is unwound, means for successively applying in overlapping relation separate lengths of drawn sheeting upon the said first sheeting material while it is moving with the conveyor belt, said separate lengths being applied transversely of the conveyor belt in timed relation to movement of the said first layer of sheeting to arrange the short lengths substantially at right angles to the said first layer, and means for applying a top layer of sheeting over the said cross lengths.

2. A machine for cross-laying drawn fibrous sheeting comprising a base, conveyor belt means mounted on the base, drafting roll means for furnishing a bottom layer of drawn sheeting to the conveyor belt from a roll of fibrous material, a winding mechanism for receiving a backing element included in the said roll of sheeting, means for exerting a light tension on the said winding means, thereby to compact fibers of the web of sheeting prior to engagement by the said drafting rolls, a carriage member movably supported on rails mounted above the conveyor belt, spring means for normally holding the carriage in a starting position, gear means for advancing the carriage for a limited distance at a rate of speed corresponding to the movement of the conveyor belt, a swinging frame pivoted in the said carriage, means for moving the swinging frame transversely across the bottom layer of sheeting on the conveyor belt during the period in which the carriage is advancing, means for returning the swinging frame across the conveyor belt during the interval in which the movable carriage is being retracted, drafting roll means pivotally secured in the swinging frame adapted to deliver drafted sheeting from the frame member, roll means mounted at the bottom of the swinging frame adapted to lay a cross length of sheeting from the frame upon the said bottom layer of sheeting, independently driven roll means for interrupting movement of the sheeting through the frame to cause separation of a cross length from the main web of sheeting in the frame, and means for applying a top layer of drawn sheeting upon cross lengths.

3. A machine for fabricating multilayer sheet material comprising a base, conveyor belt means mounted on the base, drafting rolls for furnishing a bottom layer of drawn fiber to the conveyor belt from a roll, a cross-laying mechanism for applying successively separate lengths of sheeting on the bottom layer, said cross-laying mechanism including a movable carriage supported above the conveyor belt, a swinging frame pivoted in the carriage and adapted to move in an arc transversely across the bottom layer from edge to edge, means for advancing the carriage in synchronized relation with the conveyor belt for a limited distance controlled by the interval in which the swinging frame moves across the bottom layer of sheeting, means for returning the frame to its starting position, means for retracting the movable carriage in timed relation with the frame, drafting means mounted in the swinging frame for delivering drawn sheeting to the bottom layer, a plurality of rolls for guiding the sheeting through the swinging frame, a clutch mechanism for causing two of the rolls to stop rotating and thereby break the web of material.

4. A machine for fabricating a multilayer sheet material comprising a base, conveyor belt means mounted on the base, drafting roll means for furnishing a bottom layer of drawn sheeting to the conveyor belt, a cross-laying mechanism on the belt, said cross-laying mechanism including a carriage member movably supported on rails above the conveyor belt, a transversely movable frame pivotally secured in the movable carriage, means for oscillating the frame, means for advancing the carriage and retracting it in timed

relation to the oscillation of the frame, roll means for successively applying separated lengths of sheeting from the frame to the bottom layer of sheeting, a guide element operatively connected to the swinging frame for receiving and positioning adjacent to an edge of the bottom layer free ends of the length of sheeting delivered from the frame, and means for shearing the free ends of the cross lengths of sheeting along the edges of the top and bottom layers.

5. A machine for fabricating multilayer sheet material comprising a base, conveyor belt means mounted on the base, means for furnishing a bottom layer of drawn sheeting to the conveyor belt, a cross-laying mechanism for applying successively in overlapping relation short lengths of sheeting extending in substantially right angular direction across the bottom layer, said cross-laying mechanism including a swinging frame, means for oscillating the frame from one edge of the bottom layer to the other, and means for advancing and retracting the frame in timed relation to its oscillation, drafting roll means mounted in the frame for controlling movement of drawn sheeting therethrough, a presser roll member mounted in the bottom of the swinging frame, said presser roll being adapted to lie in contact with the said bottom layer of sheeting and to compact sheeting delivered from the frame, said presser roll being mounted in a pivoted supporting structure, means for varying the angle at which the supporting structure is disposed for the purpose of maintaining the presser roll in contact with the web during oscillation of the said frame, means for separating fibers passing through the frame when the latter member has completed one movement across the bottom layer, and means for applying a top layer of drawn fiber to the separated lengths of sheeting.

6. In a cross-laying machine of the character described, the combination with a conveyor member of a cross-laying frame, means for moving the frame in timed relation to the conveyor means, a presser roll pivotally supported in said frame, a link mechanism connected to said presser roll, said link carrying a cam roller engaged in a cam member mounted at one side of the frame, a pivoted spacing bar connected to said cam for guiding the cam roller, said link and cam roller being adapted to vary the position of the presser roll in the frame in accordance with change in operative position of the frame.

7. In a cross-laying machine of the character described the combination with a conveyor member of a cross-laying frame, means for moving the frame in timed relation to the conveyor member, a plurality of sets of drafting rolls rotatably mounted in the bottom of the frame, a shaft member pivotally mounted in the bottom of frame, link means fixed to the shaft and arranged to rotate the shaft through a limited path as the frame moves, plate members fixed on said shaft and carrying a plurality of gears for driving one of said sets of drafting rolls, and means for driving the said gears in varying positions resutling from rotation of said shaft.

8. A cross-laying machine of the character described comprising the combination of a conveyor member with an oscillating frame, cam means for advancing the frame during oscillation, means operatively connected to said cam means for furnishing separated lengths of sheeting from the frame, a stop member fixed to said frame, a guide element arranged to cooperate with said stop in one operative position of the frame and position free ends of the said lengths of sheeting adjacent to said conveyor member.

9. In a cross-laying machine of the character described, the combination of a conveyor member with an oscillating frame, cam means for advancing the frame in timed relation to the movement of the oscillating frame, roll means operatively connected to said cam means, said roll means being mounted in the frame and adapted to furnish separated lengths of sheeting therefrom, a stop member projecting forwardly from the frame, a pivoted guide element arranged adjacent one side of the conveyor member in front of the frame, said guide being formed with a spring member, said spring cooperating with the stop member in one position of the frame to swing the guide into engagement with one of said separated lengths of sheeting and position same adjacent the conveyor member, and said spring member being adapted to flex inwardly to permit continued engagement with the stop member during change in direction of the oscillating frame.

10. A cross-laying machine of the character described comprising in combination a conveyor member, a longitudinally movable frame for delivering separated lengths of sheeting to the conveyor member, a pivoted link mechanism attached to the frame, spring means connected adjacent the pivot point of the link mechanism for the purpose of urging the frame from one side of the conveyor member to the other side thereof, said frame being fixed to pivoted arms, cam members cooperating with the arms to move the frame against the action of the said link and spring mechanism and thus induce oscillation.

11. A cross-laying machine of the character described comprising in combination with conveyor means of a frame member mounted in a longitudinally movable carriage by means of pivoted arms, cam means operatively connected with the arms to move the frame in one direction, a balance spring mechanism cooperating with the cam means to swing the frame in an opposite direction, said balance spring mechanism including a link member fixed on the carriage, a second link pinned to one end of the fixed link, a third link pivotally pinned to the frame at one end and to the second link at the other end and meeting the said second link at an angle, and a tension spring held between the lower end of the said fixed link and the point of joining of the two pivoted links.

12. In a cross-laying machine of the character described, the combination with a conveyor member of a longitudinally movable oscillating frame mounted above the conveyor, roll means for introducing drawn sheeting to the frame, said roll means including a backing member for separating adjacent layers of the drawn sheeting in the roll, a winding mechanism for receiving the backing member as sheeting is unwound and delivered to the said frame, the winding mechanism including a shaft having a roller slidably mounted thereon, a flange portion fixed to the shaft adjacent one end of the said roller, spring means mounted around the opposite end of the shaft and resiliently urging the roller against the flange, and means for driving said shaft to wind the backing member at a speed slightly greater than the speed at which the backing and sheeting are unwound from the said first roll.

13. A cross-laying machine comprising in combination a base for supporting a web of drawn sheeting, means for moving the base, a longitudinally movable carriage supported above the

base, an oscillating frame suspended from the carriage, said means for moving the carriage including a chain member fixed to a stationary part of the machine, a pulley mounted on the carriage operatively connected with said chain, the extremity of the chain being secured to a lever mounted on the carriage, a cam member engaging with said lever, a shaft having the cam member fixed thereon, said shaft being supported at either end in bearing members located on the carriage, gearing means for driving said shaft and advancing the carriage by means of the cam and chain mechanism, spring means connected to the carriage at one end and having its other end fastened to a stationary part of the machine, said spring member being adapted to retract the carriage.

14. In a cross-laying machine of the character described the combination with a conveyor member of a longitudinally movable carriage having an oscillating frame suspended therein and means for swiveling the frame in the carriage to vary the angle through which the frame oscillates relative to the conveyor member.

15. In a cross-laying machine of the character described, the combination with a conveyor member of a longitudinally movable carriage having an oscillating frame suspended therein, means for swiveling the frame the vary the angle through which the frame oscillates relative to the conveyor member, said means including brackets having annular slots formed therein, plate elements forming a part of the carriage slidably supported in said slots, and means for securing the plate in fixed relation to the slotted bracket.

16. A cross laying machine of the character described, including a conveyor member, means for bringing a layer of drawn fibers to the conveyor, a movable carriage supported above the conveyor, means for alternately advancing and retracting the carriage in timed relation to movement of the conveyor and parallel therewith, a vertically disposed fiber drafting frame having its upper portion pivotally suspended from intermediate portions of the carriage, said frame being arranged to oscillate transversely with respect to the path of movement of the carriage.

17. A cross laying machine of the character described, including a conveyor member, means for bringing a layer of drawn fibers to the conveyor, a movable carriage supported above the conveyor, means for alternately advancing and retracting the carriage in timed relation to movement of the conveyor and parallel therewith, a vertically disposed fiber drafting frame having its upper portion pivotally suspended from intermediate portions of the carriage, said frame being arranged to oscillate transversely with respect to the path of movement of the carriage, and means for limiting the arc of rotation of the lower side of the frame from a point immediately above one edge of the conveyor to a point above an opposite edge thereof.

18. A cross laying machine of the character described, including a conveyor member, means for bringing the layer of drawn fiber to the conveyor, a movable carriage supported above the conveyor, means for alternately advancing and retracting the carriage in timed relation to movement of the conveyor and parallel therewith, a vertically disposed fiber drafting frame having its upper portion pivotally suspended from intermediate portions of the carriage, said frame being arranged to oscillate transversely with respect to the path of movement of the carriage, means for limiting the arc of rotation of the lower side of the frame from a point immediately above one edge of the conveyor to a point above an opposite edge thereof, presser roll means operatively connected to the said limiting means for engaging against and pressing a length of drawn fiber as it is applied to the conveyor, separately driven roll means for separating a length of drawn fiber which has passed through the frame, and a clutch mechanism responsive to movement of the said limiting means for interrupting operation of the separately driven roll means when the frame is in a position immediately above one side of the conveyor.

19. A cross laying machine comprising the combination with a conveyor member of a longitudinally movable carriage, a frame suspended from the carriage, a part of said frame being oscillatable transversely of the conveyor member, presser roll means mounted in the frame, a link mechanism for engaging the presser roll with the conveyor and cam means operatively connected to the link mechanism for adjusting the presser roll in accordance with change of position of the oscillatable frame in order to maintain a uniform pressure of the presser roll against the conveyor member.

20. An apparatus of the character described including a stationary base, a conveyor belt supported on the base, a longitudinally movable carriage located above the conveyor, a vertically disposed frame pivotally mounted in the carriage, cam operated means for urging the frame in one direction transversely above the conveyor belt, a spring and link mechanism arranged to return the frame from the position into which it is moved by said cam operated means.

21. A cross-laying machine including in combination a conveyor and means for moving said conveyor longitudinally, an oscillatable frame and means for moving said frame longitudinally of the conveyor as it is oscillated laterally of the conveyor, and means to draw a web from a supply and to lay it across a longitudinally disposed web carried by said conveyor including a shaft pivoted adjacent the lower end of said frame, plates fixed to said shaft and a plurality of rolls pivotally carried by said plates for feeding and depositing said web, a driven gear adjacent said pivot shaft, gears for each roll intermeshing with each other and with a freely rotatable gear on said pivot shaft, said last mentioned gear meshing with and being driven by said driven gear, an arm fixed to said pivot shaft and link means attached thereto and effective as controlled by cam means for varying the position of said rolls for feeding and depositing the web as it is oscillated transversely of the base.

22. A cross-laying machine of the character described comprising in combination a longitudinally movable conveyor member, an oscillating frame for delivering separated lengths of sheeting to the said conveyor member, a link mechanism attached to the frame for moving said frame longitudinally with the conveyor and at a synchronous speed therewith, cam means for swinging said frame in one direction laterally of the conveyor for laying a cross web, and resilient means operatively connected to said frame for urging the frame from one side of the conveyor member to the other side thereof and in opposition to the cam means.

23. In a machine for cross-laying fibrous webs the combination of a conveyor for advancing a layer of fibers longitudinally of the conveyor and

layer and a carriage movable longitudinally of said conveyor and means forming a part of said carriage and guided for movement laterally of the conveyor for laying a series of lengths of fibers transversely of the first mentioned layer, and means to draw and to feed said transverse lengths including spaced pairs of rolls rotatably supported by and movable with said laterally guided means between which the fibers are passed, one roll of each pair being disposed at one side of said lengths of fibers and the other roll of the pair being disposed at the opposite side thereof, and means for driving one pair of rolls continuously and another pair thereof intermittently and means to control the intermittent operation of said rolls so as to part the fibers fed thereby adjacent one edge of the conveyor and to start drawing and feeding them adjacent the other edge, and a pair of presser rolls between which the feeding fibers are advanced as they are laid across the longitudinally disposed layer, and means for moving the said presser rolls to and from the surface of the longitudinally moving layer to maintain a substantially even spacing of the rolls from the layer throughout the full extent of movement of the transverse laying means.

24. In a cross-laying machine of the character described, the combination with a conveyor of uprights supporting spaced-apart rails, a longitudinally movable carriage supported on wheels and arranged to roll along said rails, said carriage including oppositely disposed side members, a base plate superimposed on the side members and having arcuate slots formed therein, angle supports adjustably secured on the slotted base plate, said angle supports carrying a base member, brackets fixed to the base member, pivot means on said brackets, a frame member pivotally suspended from said pivot means and means carried by the base member for oscillating the frame transversely with respect to the path of movement of the carriage.

25. In a machine for cross-laying fibrous webs the combination of a conveyor for advancing a layer of fibers longitudinally of the conveyor and layer and a carriage movable longitudinally with said conveyor and means forming a part of said carriage and guided for movement laterally of the conveyor for laying a series of lengths of fibers transversely of the first mentioned layer, and means to draw and feed said transverse lengths including spaced pairs of rolls rotatably supported by and movable with said laterally guided means between which the fibers are passed, one roll of each pair being disposed at one side of said lengths of fibers and the other roll of the pair being disposed at the opposite side of the lengths of fibers, and means for driving one pair of rolls continuously and another pair thereof intermittently and means to control the intermittent operation of said rolls so as to part the fibers fed thereby adjacent one edge of the conveyor and to start feeding them adjacent the other edge.

CARL D. BROWN.
GEORGE E. REPASS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
33,426	Butler	Oct. 8, 1861
363,217	Dolge	May 17, 1887
1,351,678	Nuckols	Aug. 31, 1920
1,434,917	Sewall et al.	Nov. 7, 1922
1,719,897	Mayo	July 9, 1929
1,886,919	Sturgis	Nov. 8, 1932
1,946,113	Ross	Feb. 6, 1934

FOREIGN PATENTS

Number	Country	Date
95,840	Germany	Jan. 15, 1898